SANITATION ON THE PANAMA CANAL ZONE, TRINIDAD AND BRITISH GUIANA

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INTRODUCTION

In September, 1912, I was sent on an expedition to the Panama Canal Zone by the Liverpool School of Tropical Medicine to study certain malarial problems with Dr. James, Chief Assistant Physician to the Ancon Hospital. The American Canal Commission kindly allowed me to stay in the Ancon Hospital, and it was there that we conducted our researches. Although occupied for the most part with special research, I was nevertheless able, during my three months' stay, to see most of the sanitary work going on. I received much information on the subject from the medical men in the

hospital, and Colonel Gorgas, Chief Sanitary Officer, Colonel Phillips and Mr. Le Prince, Chief Sanitary Inspector, were always willing to give me all the information that I required regarding their organisation and the methods employed. Moreover, I walked over most of the line of the Canal Zone with Dr. Orenstein, Chief Assistant Sanitary Inspector, who was most kind in showing me everything that he possibly could regarding the anti-malaria work. After all that I have seen there, I feel compelled to express much admiration regarding the great system of sanitation, and nothing was apparently left undone in the eradication of malaria and other diseases in general. There was no apparent defect in Colonel Gorgas's sanitary administration. All trusted him in his work with implicit confidence, and the highest authorities gave him power to do what he considered best in great as well as in small measures. The money required was granted with the full belief that it was necessary for the good health of the American inhabitants, and for all workers on the Canal. They realised that good health was to be obtained at all costs, not only for its own sake, but in order to enable them to finish the great undertaking which they had commenced. The Americans, in the Canal Zone at least, are convinced that sanitation 'pays.' They had before them the great lesson of the disastrous failure of the French Canal diggers, and they have learnt that lesson well. No one who had not lived on the Canal Zone before the Americans took it over could possibly realise fully the great changes that have been brought about. The Ancon cemetery, which is a veritable forest of tombstones erected chiefly to French victims (Pl. XII, fig. 9), helps one to realise that in bygone times the risk of death was very high. In an unhealthy tropical country like West Africa, there is always a feeling of insecurity. People are constantly sick, many die, and one feels that perhaps one's own turn is coming next. Mosquitos abound, one is constantly bitten; mosquito nets may be used, quinine may be taken every day, and even though one is careful to drink only filtered or boiled water, yet a feeling of security against malaria and dysentery is never felt. So it was in Panama less than ten years ago. Formerly mosquitos were a plague on board vessels lying in Colon harbour, but since the American occupation that is all changed, and now no mosquitos come aboard. I

arrived on the Canal Zone fully equipped, among other things, with a mosquito net and plenty of quinine which are always so necessary in tropical expeditions, but soon realised that both the mosquito net and the quinine were not needed. There were no mosquitos about, and every American house was mosquito-proof. My three months' stay covered the latter part of the rainy season and the commencement of the dry season, yet during all that time I feel sure that I was not bitten by a single mosquito,* and in consequence I did not take one single grain of quinine. The water supply was good, and was frequently examined bacteriologically. Healthy European women and children were met everywhere, no one seemed to be ill, and one felt as secure from disease as anywhere in temperate climates. I have been in Sierra Leone, Forcados, Bonny and Old Calabar on the West Coast of Africa, also in Trinidad, British Guiana and Jamaica. In all of these places I was bitten by mosquitos, even though my stay had been only for a few days. In all I had to take quinine as a prophylactic against malaria. In these places, moreover, there are not so many white women and children seen as on the Canal Zone at Panama. In West Africa there are no white children and few white women, for the simple reason that it is too unhealthy. I think I have said enough to indicate, without going into the statistics of death-rate, etc., that Panama, once notorious as a white man's grave, is now as healthy as most temperate countries, and the favourable reports which may be read concerning this matter are in no way exaggerated. I have known several traders whose occupation has brought them many times to the Canal Zone during the last ten to fifteen years, and all alike marvel at the great changes which have occurred for the better in so short a time. Most of the authentic reports on the improved health in Panama have been gleaned from the statements made by Colonel Gorgas. He has in no way exaggerated the results of his sanitary work. Again, it must be remembered that this greatest achievement in tropical sanitation, which the world has yet seen, reflects great credit, not only on Colonel Gorgas and his staff, but also on the highest officials on the Canal Zone and on the American Government who have supplied the money without

* Mosquitos are fairly common still at Frijoles and Monte Lirio.

complaint and without putting obstructions in the way, actively or passively, and who have been among the first to realise that thorough sanitation in the tropics 'pays financially.'

COMMENCEMENT OF SANITATION ON THE ISTHMUS

Plans for the sanitation of Colon and Panama formed part of the discussion at the American Commission of 1899-1901. These towns, although situated on the Canal Zone, belong to the Republic of Panama. In January, 1904, the quarantine of Colon and Panama was turned over to the United States, and in June of that year the permanent sanitary organisation was established with Colonel W. C. Gorgas as head and Dr. H. R. Carter, a yellow fever expert, as the Director of Hospitals. The work was hampered by scarcity of supplies, notably copper wire screening, which could not be purchased in the United States in large quantities. An epidemic of yellow fever, lasting from July, 1904, to December, 1905, accelerated the delivery of supplies, and made it necessary to expedite the sanitation work, lest the force slowly organising be depleted. There were 246 cases and 84 deaths, all of which were among the non-immunes who had come to the Isthmus on account of the Canal work. The Americans commenced sanitation, therefore, before attempting any operations on the Canal. They realised that it would be advantageous to make the place healthy before bringing the white population there. They were pioneers in that they built every house mosquito-proof.

SANITATION IN COLON

This town is situated at the Atlantic end of the Canal. It has a population of 18,000. In 1904 it had a population of 10,000, and about 9,000 of these lived in shanties built on piles. At high tide the houses were surrounded with water, so that no one could walk along the streets without danger of falling into the mire (Pl. XI, figs. 1, 3). Behind the town was a large mangrove swamp. There was no proper water supply, and no sewage system. Mosquitos abounded, and malaria and other diseases ran riot. Since then the town site has been filled in by the Americans. It has been raised several feet, so that it is now dry, well paved (fig. 2),

clean, well drained and healthy, with a modern sewage system and water supply. The Panama Republic and the Panama Railway Company are paying for the work.

SANITATION IN PANAMA TOWN

Panama is situated near the Pacific end of the Canal, and has a population of about 37,000. As already stated, there was a yellow fever epidemic raging there from July, 1904, to December, 1905. This, however, was the last of the disease in that town. The Americans in a little over a year eradicated it entirely, and the conditions are now such that it could hardly exist there again. This alone is a triumph which must have already paid financially many fold. Panama Town had previously been an endemic yellow fever centre for centuries, and in a little over one year the disease was stamped out and not a single case has occurred there since. The methods adopted to control the epidemic were isolation of all cases as well as suspected cases, in mosquito-proof quarters, and thorough fumigation of all houses which had cases or suspected cases, in order to kill the mosquitos in them. At the same time a campaign was started to destroy the breeding places of the *Stegomyia fasciata*. At that time every house in Panama had roof gutters and water tanks or barrels, this being almost the sole water-supply of the town. There was no proper drainage or sewage system. The streets were unpaved, without proper gutters, and in the rainy season became a hopeless quagmire (fig. 4). The conditions, therefore, favoured greatly the breeding of the *Stegomyia fasciata*. The Americans employed no makeshift methods in remedying these defects. They brought in a proper pipe-borne water-supply from a reservoir. They installed into every house modern closets, with a pipe-borne sewage system. They paved and guttered every street (fig. 5), and removed as far as possible all the roof gutters from the houses along with the water barrels. They enforced strict sanitary regulations on the inhabitants of the town, and established a health department to see that these regulations were carried out. In addition, the ground floors of the houses were rendered uninhabitable to rats by cementing, and cement gutters were constructed alongside the pave-

ments in order to catch the rain from the gutterless eaves of the houses. These were the drastic measures enforced on the inhabitants of Colon and Panama. The Americans lent the money and supplied the labour. It cost the two towns about £455,000. They are paying it back with interest through water rates which are collected directly by the United States. The inhabitants who had lived there in a slovenly way without interference, as their forebears had done for centuries, were naturally very angry at this apparent tyranny, but already they are becoming satisfied. Those who have families have already noticed an unprecedented freedom from disease among their children. Plague, typhoid fever, dysentery and malaria are no longer to be feared, and now they realise that what was done was good. The sanitation of Colon and Panama is to-day as up-to-date as in any town in Europe. The water-supply is examined very frequently by expert bacteriologists. The quarantine at Panama and Colon is most rigid. Guayaquil in Ecuador is an endemic yellow fever centre, and is only about four days' sail from Panama, hence a very strict quarantine is necessary. In fact, if the Ecuadorians do not soon take steps to make their town sanitary, it is highly probable that the Americans will force them to do it, as it is a constant menace to the health of Panama. Trinidad and all Venezuelan and Colombian ports are under quarantine for yellow fever, though I believe that since my return Trinidad has been removed from the list.

SANITATION ON THE ZONE OF THE CANAL—ANTI-MALARIA WORK

On the Canal Zone the most prevalent disease has been malaria, and much of it is pernicious malaria. The sanitary measures adopted were, therefore, principally anti-mosquito measures. Countless swamps and Anopheles breeding places existed along the line of the Canal. A huge swamp lay behind Colon, and extensive swamps also surrounded the town of Panama. After enormous labour, these have been filled up by material excavated from the Canal. Two methods have been adopted in filling the swamps. One consists in dumping material (rock and earth) into them from railway waggons. The other method, known as a 'hydraulic fill' (Pl. XII, fig. 8), is to force into them a liquid stream of mud

and sand through pipes leading from large suction dredgers employed in deepening the Canal. In many cases these pipes are laid long distances, even a mile or more distant from the Canal. I have seen swamps filled in this way to the depth of many feet, so that only the tops of the trees which grew in these swamps are now visible (fig. 8). Large unhealthy areas have been obliterated in this way. The present town of Balboa on the Pacific entrance to the Canal is being built on one of these filled-in swamps. Strictly speaking, however, these huge undertakings can hardly be considered as anti-malaria work. In describing this, I cannot do better than give an abstract of a paper by Colonel Gorgas (1909) on the subject.

He states that the anti-malaria work on the Isthmian Canal cannot be well understood unless preceded by a brief description of the sanitary organisation as it bears upon this work. The bulk of the activities of the Department of Sanitation on the Isthmus has no immediate bearing upon sanitation, namely, that which deals with religious instruction, care of the sick, care of the insane, of lepers, street cleaning, garbage collection, etc. The Department of Sanitation spent in 1908 some two million dollars, but only five hundred thousand dollars (£100,000) of this was spent on pure sanitation. The American Canal Zone consists of a strip of land ten miles wide, of which the Canal is the centre. This strip extends about forty-five miles in length from North to South. The population to be protected against malaria consists of about 50,000 labourers and their families, and is scattered all over this five hundred square miles, though they are principally collected along the line of the Canal, more particularly into some forty camps and villages near this line. The temperature, rainfall, and character of the terrain are all excellently suited for the breeding of Anophelines all over this territory (fig. 7). The rainfall averages over 100 inches yearly, and though there are four months in which there is practically no rainfall, there is enough water for the Anophelines to breed freely during these four months. During the five years of occupancy of the Isthmus up till 1909, 250,000 people have resided in this zone, and these have been located principally in places formerly unoccupied along the line of the Canal, and as the villages are intended for only temporary

occupancy, the conditions are a good deal like those of an army going into a new country, and increase the difficulty of sanitation enormously.

The anti-malarial measures consist:—

1. In destroying the habitat of the Anophelines, during their larval stage, within a hundred yards of dwellings.

2. Destroying within the same area all protection for the adult mosquito.

3. Screening all habitations so that mosquitos cannot have access.

4. Where breeding places cannot be destroyed by draining, use is made of crude oil and larvicide.

These measures are given in the order in which they are considered important.

For the purpose of carrying into effect these measures, the five hundred square miles of territory have been divided into seventeen districts. These districts are under the charge of a Chief Sanitary Inspector, who has in his office the necessary clerical force and three assistants. One of these assistants is especially competent in the life-history and habits of the mosquito, another in knowledge of ditching, tile-draining, etc., and the third in knowledge of general executive work. Each of the seventeen districts has a District Sanitary Inspector in charge. Each District Inspector has a sufficient force of labourers (forty to fifty) to do the necessary ditching and draining. A force of carpenters is required to keep the screening in repair, and there are one or two quinine dispensers who are kept constantly going around giving doses of quinine to those who desire it. It is not attempted to enforce prophylactic quinine. The Chief Sanitary Assistants are kept constantly going over the work advising and instructing the District Inspectors. The District Physician sends in daily to the central office a report of the number of cases of malaria and the number of the employees from which these cases come. This report is made up weekly in the central office. A copy is sent to each District Inspector, and he is held responsible for any excess of malaria in his district. If the admission rate for malaria during the week rises above $1\frac{1}{2}$ per cent. something is considered wrong, and the assistants of the Chief Sanitary Inspector are sent to look over the

ground to try to discover the cause. The District Inspector, for the purpose of doing away with the breeding places of larvae, puts down tile drains wherever they would be suitable. This is considered the most effective and economical form of drainage. After it is laid down it requires no more attention. There is no breeding place left for mosquitos, as no water whatever is exposed at the surface. A horse mower or scythe can be used for cutting the grass over it. Where tile-drainage cannot be used, open concrete ditches are put down. The first cost of this is nearly as great as that of tiling, and a certain amount of labour is necessary to keep the ditches clear. They must be swept out once a week. If the ground cannot be drained in either of the above ways, open ditches are used. This is the least effective and most expensive form of drainage. In Panama they fill up rapidly with grass, and have to be cleaned out about once in two weeks. They are always breeding places for mosquitos, and have to be constantly treated with oil or larvicide.

For the purpose of doing away with places which will harbour the adult mosquito, the inspector clears the ground of brush and grass for a hundred yards around the place to be protected. Where the locality is to be occupied for a year or more, it is more economical to grade the ground and plant grass, which can then be kept down with a horse mower or scythe. A limited amount of shrubbery and a few trees about a dwelling are not objectionable. The inspector keeps the wire screening in repair by constantly going over it with a force of carpenters. Good wire should last on the Isthmus at least three years. The inspector uses crude petroleum or larvicide in such places as cannot be drained, and in temporary pools caused by construction or at temporary camps where it would not be economical to drain. Usually when a new location is occupied the malaria rate is high, frequently as high as 25 per cent. a week, but always in the course of a month or two, when the ground is drained and the brush cut, this drops to a rate somewhere about 1 per cent. The above methods could be applied to a considerable extent to military organisations. Where troops remained at one camp for a week or longer, it would be practicable to clear and drain the ground. It is most important that the Sanitary Inspector should attend to the work himself. The men

who do the ditching and brush-cutting, etc., should be immediately under his control, and he should be held responsible for the proper performance of the work, or in other words, the work must be constantly supervised by a man who has a considerable knowledge of these anti-malarial measures. Prophylactic quinine is looked upon as an important measure, and is offered in three grain doses to all employees who will take it. It is placed on the table in all the messes in liquid and pill form, and one to three dispensers are employed in each district who go around the various villages.

Fuller details may be had from articles by the following authors:—W. C. Gorgas (1904, 1906, 1907, 1908, 1909, 1910, 1912), A. J. Orenstein (1911, 1912), J. A. Le Prince (1908), and S. T. Darling (1910, 1912); also from the Reports of the Department of Sanitation of the Isthmian Canal Commission by W. C. Gorgas, and from the Canal Record.

The anti-malarial work, therefore, on the Canal Zone consists simply in carrying out thoroughly and in a straightforward manner the anti-malarial principles laid down by Ross soon after his discovery of the transmission of malaria by the Anopheles mosquito. Yet simple though these principles seem, the methods and organisation of Colonel Gorgas deserve the most careful study. His system has produced most remarkable results in a country which was exceedingly unhealthy and in which the difficulties were great and many, and although the construction of the Canal brought unlimited labour and material to his aid, yet it also greatly increased his difficulties, because it is well known that malaria tends to increase greatly where land excavation is going on, on account of the innumerable new breeding pools which are produced by these excavations. This alone necessitates the constant inspection and tackling of ever-changing conditions. The working population is constantly changing its location, and this also involves many difficult sanitary problems and increase of sanitary work. The working population on the Canal moves about so much that these methods are even suitable, as Colonel Gorgas has said, for military organisations in the tropics. It seems to me that the keynote of the success is thoroughness in every detail. With regard to mosquito-proof buildings, even the signal-boxes on the railway are mosquito-proof, and special arrangements have been made so that mosquitos

cannot gain an entry where the wires run into these buildings to the operating levers. The quarters in which the European labourers live are mosquito-proof, but it is found that they are careless in leaving the doors open at times. To safeguard them, mosquito catchers are sent into these dwellings every morning to catch the mosquitos which have gained entry. Most of the insects are filled with blood, having fed during the night. Many mosquitos which might have become infected are therefore destroyed. Dr. Orenstein (1912) has found that this procedure reduces the malaria rate. Oil and larvicide are used so freely that it is very difficult to find any trace of larvae in pools not yet drained or filled in or in ditches not yet concreted. In order to emphasise further the thoroughness of the sanitation on the Canal Zone, I give the following list of the personnel under Colonel Gorgas.

The personnel of the Division of Zone Sanitation is as follows:—

1 Chief Sanitary Inspector.
1 Chief Assistant Sanitary Inspector.
2 Division Inspectors.
26 Inspectors.
1 Inspector—Entomologist.
18 Foremen and 226 labourers.

The following is a summary of the routine work accomplished by this personnel during the month of July, 1912:—

Anopheles work:

Linear feet of ditches cleaned	129,150
Linear feet of new ditches dug	710
Square feet of grass cut and removed	736,300
Number of loads of grass removed to dump	494
Number of cubic yards of earth used in filling holes, etc.	28
Districts oiled, each four times in routine: Chorrillo, Cocoa Grove and Avenida Ancon; San Felipe, Santa Ana and Trinchera; Pueblo Nuevo, San Miguel and Caledonia; Guachapali, Maranon and Panama Railroad yards; special oiling as found necessary.	
Larvacide used .....gallons	500

Disinfection and fumigation:	
Houses disinfected and fumigated for diphtheria...	3
Houses disinfected and fumigated for typhoid fever	1
Houses fumigated for yellow fever.....	6
Number houses disinfected	4
Number houses fumigated	10
Number rooms disinfected	10
Number rooms fumigated	38
Total number cubic feet disinfected	16,300
Total number cubic feet fumigated	369,300
Destruction of rats:	
Rats caught in traps	496
Number of rat traps in use daily	200
Inspection of houses and yards:	
Number of yards cleaned.....	132
Loads of refuse hauled to dump.....	33
Number of old buildings condemned and demolished	1
Number of notices to abate nuisances served by inspectors	42
Number of inspections by reinspector	123
Number of notices complied with	39
Number of letters to alcade requesting enforcement of sanitary rules and regulations	1
New buildings:	
Number of plans submitted to Health Officer and approved	19

The Sanitary Inspectors are thoroughly trained men. They undergo courses of instruction and have to pass examinations. I would refer those interested to the 'Manual of Instruction for Sanitary Inspectors,' published by the I. C. C. Press, Mount Hope, Canal Zone, 1912. Everything goes to show the thoroughness of this great sanitary organisation.

ANTI-YELLOW FEVER WORK

Despite the fact that no case of yellow fever originated on the Canal Zone since May, 1906, yet the efforts to eradicate the *Stegomyia fasciata* have not been abated. The Sanitary Inspectors

exercise great vigilance in preventing accumulations of water in containers where *Stegomyia* might breed. Roof gutters are not allowed, except self-draining, short gutters over the entrance to the house. No water containers are permitted at any house within a 300 foot radius of a public water supply, nor, of course, at any house where there are water connections. In localities more than 300 feet distant from a public water supply, only screened containers are allowed. The Sanitary Department supplies the material for screening one container at each house. Measures for eradicating *Stegomyia* have been so successful that an adult *Stegomyia* is considered a great curiosity, and it is becoming difficult to obtain *Stegomyia* larvae in the sanitated area of the Canal Zone.

SANITARY MEASURES ADOPTED TO SAFEGUARD AGAINST PLAGUE

The quarantine is exceedingly strict, as plague is endemic in Guayaquil, which is only four days' sail from Balboa. Houses are rendered as far as possible rat proof by cementing the floors or by building them on piles. Rats are constantly being trapped and poisoned, and all rats caught or found dead are immediately immersed in antiseptic and sent to the laboratory for examination. Night soil and garbage are placed in special garbage tins with lids. It is removed daily to be burnt and buried. It is the duty of the Sanitary Inspectors to attend to this.

MEASURES AGAINST ANKYLOSTOMIASIS

This disease is very common, especially among the negroes. It is combated by the establishment of a very thorough latrine system along the line of the Canal. The Sanitary Inspectors look after the latrines in their respective districts. The latrines are fly-proof earth closets, and their position is frequently changed. When the contents of the pit reach within two feet of the ground surface, the pit must be filled, after liberally covering the contents with unslaked lime or other disinfectant. The fill must be banked at least 18 inches above the surrounding ground surface. Patients coming into the hospitals and dispensaries are constantly examined for ankylostome ova, and they are given a thorough course of santonin treatment if these are found.

ANTI-TYPHOID AND ANTI-DYSENTERY WORK AND GENERAL SANITATION

The reservoirs and their watersheds are kept free from human habitation and trespass, and the water is periodically examined chemically and bacteriologically.

Garbage cans are cleaned daily, and the garbage is either burnt or buried each day. Manure is burnt to prevent fly breeding. Pit closets are rendered fly proof. Literature is distributed among the people to call attention to the danger of flies.

Sanitary Inspectors carry out all the fumigation and disinfection necessary. In bacterial diseases, such as diphtheria and typhoid fever, thorough disinfection of utensils, floor clothing and bed clothes is carried out.

THE HOSPITALS ON THE CANAL ZONE

There are two principal hospitals on the Canal Zone. One at Colon on the Atlantic side of the Canal, with 450 beds, and the other at Ancon on the Pacific side of the Canal, with 1,500 beds. In addition there are several dispensaries along the line of the Canal. These hospitals were in part located and built by the French. They consist of a series of wooden buildings built on piles and are entirely mosquito-proof (Pl. XII, fig. 6). The buildings are spread out after the fashion of a fever hospital in this country, and the grounds are beautifully laid out. These buildings, like all other American dwellings on the Canal Zone, are for the most part two stories high. A few are three stories in height and many only one storey. They are cool, airy and well shaded. The wire-screening as a rule goes all round the building (fig. 6), but in some cases, especially in the smaller buildings, only two or three sides are screened. The remaining sides consist of wood, with one or two screened windows. The outside walls, so to speak, are therefore composed of wire screening in a wooden framework. The roof consists of corrugated zinc or tile. The eaves, which have no gutters except for the part immediately above the entrance to the house, project about four feet beyond the screened framework, and the water from these falls into a concrete open ditch all round the house. Inside the wire-screening is a space varying from about three to four yards wide, forming a sort of protected

verandah. Then comes the house proper with sitting-rooms and bedrooms, or wards in the case of a hospital building. The walls of the house proper consist of wood with doors and large lattice windows, so that air or wind can pass through the whole building. The rain practically never gets within the wire screen on account of the projecting eaves, and the inhabitants live for the most part in the verandahs immediately within the wire-screening, and therefore practically in the open air. The doors forming the entrance to the buildings are usually double, and consist of a skeleton framework screened with wire. They have strong springs attached so that they shut automatically. The screening consists of pure copper gauze, eighteen meshes to the inch, and lasts as a rule for three years or more.

The hospitals are as well equipped and up to date as any European hospital. All the nurses are white, and each separate building has a laboratory attached with up-to-date microscope and other necessary equipment. The pathological department is likewise large and up to date. At least two of the medical men are employed chiefly on research work.

I feel sure that Ancon Hospital is the most modern and best-equipped hospital in the whole of the tropics. There is only one criticism, it seems to me, to be made regarding the anti-malaria work on the Canal Zone at Panama, namely, that the malarial patients are not subjected to a sufficiently long treatment with quinine. Malarial patients (non-American) remain in hospital only for a few days after their attack of fever has subsided under quinine treatment, and hence a relapse is almost certain. Many patients come to hospital several times a year for malaria, and in the present state of sanitation, it seems improbable that each of these attacks is likely to be a fresh infection. In fact, I am inclined to believe that probably 80 per cent. of the cases of malaria now occurring on the Canal Zone are relapses due to an insufficient course of quinine treatment. The mild character of the cases coming into hospital and the number of re-admissions lead me to this belief. This fault does not lie with the medical men, but is due to the fact that the patients (non-American) do not receive their pay during their stay in hospital, and therefore they are anxious to leave as soon as they feel well, before being properly cured. I believe that a three weeks'

course of thorough quinine treatment safeguards against relapse in most cases. If such a treatment could be given to all patients before they were allowed to leave hospital, I feel sure that malarial fever among the workers on the Canal would finally disappear. The American patients, as a rule, receive a thorough course of treatment before leaving hospital, and malaria is now practically non-existent among them.

RESULTS OF THE SANITATION ON THE CANAL ZONE

In the introduction I have already mentioned the remarkable improvement in health and comfort brought about since the American occupation.

With regard to the remarkable statistical results of the sanitation in Panama, I will again quote from Colonel Gorgas (1911), as follows:—'The health conditions at Panama when the United States took charge in 1904 were very bad. For four hundred years this Isthmus had been considered the most unhealthy spot in the world and the mortality records will sustain this opinion. . . . At one time the construction company of the old Panama Railroad imported 1,000 negroes from the West Coast of Africa, and within six months these had all died off. At another time, for the same reasons, they brought over 1,000 Chinamen and within six months these had all died off. One of the stations at present on the Panama Railroad is called Matachin. The tradition is that this name is derived from the Spanish words mata, 'killed,' and chin, 'Chinamen,' because this was the point where the 1,000 Chinamen were housed and where most of them died. . . . The French lost 22,189 labourers by death from 1881-1889. This would give a rate of something over 240 per thousand per year. . . . Our maximum rate in the early days was 40 per thousand; our rate at present is 7·5 per thousand. . . . The malaria sick rate we have reduced from 821 per thousand to 187 per thousand. But most important of all, yellow fever has been entirely banished. We have not had a single case since May, 1906. . . . The sanitation has cost less than 1 per cent. of the total appropriation for all purposes. . . . We hope that our success at Panama will induce other tropical countries to try the same measures; and that

thereby gradually all the tropics will be redeemed and made a suitable habitation for the white man. But if this is to come about, it must be shown that it can be done at reasonable cost and within the moderate means of the tropical region. . . . I wish therefore to say most emphatically that considering the results and difficulties surrounding the subject, the sanitation of Panama has not been costly. When the Canal shall have been finished it can be shown that sanitation cost about 365,000 dollars (£73,000) per year. For a population of 150,000 this means an expenditure of about 1 cent (one halfpenny) per caput per day, and this sum is well within the means of any tropical country.'

In another article (1910) he made the following interesting statements:—'But I do not believe that posterity will consider the commercial and physical success of the Canal the greatest good it has conferred upon mankind. I hope that as time passes our descendants will see that the greatest good the construction of the Canal has brought was the opportunity it gave for demonstrating that the white man could live and work in the tropics, and maintain his health at as high a point as he can, doing the same work, in the temperate zone. That this has been demonstrated none can justly gainsay. . . We therefore believe sanitary work on the Isthmus will demonstrate to the world that the white man can live and work in any part of the world and that the settling of the tropics by the Caucasian will date from the completion of the Panama Canal.'

SANITATION IN TRINIDAD

On my return from Panama I was able to spend seven days in Trinidad and four days in British Guiana, and although the time was too short to look thoroughly into the question of sanitation in these places, yet in that short period I was able to gain at least some superficial information. My account of the sanitation in these latter places is therefore much shorter than I would have liked.

With regard to malaria in Trinidad, the report of the Surgeon-General for 1911-1912 shows that this disease stands third in the list as a cause of death. The number of deaths from malaria in that year was 722. This is sufficient to show that malaria is very prevalent,

yet very little anti-malarial work is carried on there. One is bitten by mosquitos frequently, yet there are practically no mosquito-proof houses on the island except those of the American Asphalt Company and some of the oil companies. Only one Government residence has been made mosquito-proof, namely, that of the District Medical Officer at Erin. A residence for the District Medical Officer at La Brea is about to be erected, but we believe that the Finance Committee refused to vote the necessary funds for screening it. Furthermore, neither funds nor encouragement are forthcoming to eradicate even the smallest Anopheles breeding places. Some oil and larvicide are employed in some breeding places about the Port of Spain and at a few other places, but this is only done spasmodically.

There are practically no men employed in anti-mosquito work except in Port of Spain, where *Stegomyia* reduction against yellow fever is persistently and more or less successfully pursued, but much more might be done if more trained and efficient Sanitary Inspectors were employed. There are five Assistant Sanitary Inspectors in Port of Spain and three or four for the rest of the colony, but how far these have been trained in tropical sanitation I am unable to state.

With regard to anti-yellow fever work, there are no legal powers to enforce the abolition of eaves gutters, which are an incessant source of *Stegomyia* breeding.

Water barrels are rarely in evidence in the town because of the ample pipe-borne water supply. This water supply, by the way, is not above suspicion, as a considerable epidemic of typhoid fever occurred last year. The streets in Port of Spain are beautifully laid out and well paved, but there is no proper law with regard to garbage disposal, and I understand that proper garbage receptacles, with metal covers, are not provided by the General Board of Health.

Plague is endemic, and large sums of money are spent on rat extermination, etc., yet all kinds of filthy house garbage are placed in open boxes, old baths, barrels or baskets on the pavements, and their contents are liable to be scattered about by fowls, dogs, etc.

There is much ankylostomiasis on the island, yet no estate provides latrine accommodation for its coolie labourers, whether indentured or not.

I need hardly point out, therefore, that in sanitation Trinidad is far behind Panama. This is not the fault of the medical staff, who are constantly urging the advisability of improvement in all these matters. The fault lies with the municipalities and those in power, who are slow to act or to give support either morally or financially.

SANITATION IN BRITISH GUIANA

I have more praise for British Guiana, not because it is more healthy than Trinidad, but because one can see more serious efforts being made there with regard to sanitation than in the latter. British Guiana is an exceptionally difficult place to deal with. All the sea coast, including Georgetown the capital, lies below the level of the sea at high water. A sea wall keeps out the sea during high water, and numerous canals empty their contents through the gates at low water. These canals are essential to drain off the water which collects on this low-lying land. They cannot possibly be dispensed with, but fortunately they are kept comparatively free of mosquito larvae by the swarms of little fish which live in them. Georgetown swarms with mosquitos, one cannot avoid being bitten. It is a large town, beautifully laid out like a garden city, and most of the mosquitos there have been bred in the town itself, or at least very close to it. There are no mosquito-proof houses in the town or elsewhere, and every house has rain gutters on the eaves, leading into barrels or large tanks, as this is practically the sole water supply for drinking purposes. These rain gutters are a constant source of supply of mosquitos. Dr. Wise (1911) has found that 58·3 per cent. of the premises in Georgetown are breeding grounds for mosquitos, the great majority of these being *Stegomyia fasciata*. Several of the streets in the town also have old canals running through them (Pl. XIII, fig. 10). These are a serious defect on account of mosquito breeding. Several of them have been filled in by town rubbish (fig. 11), and finally converted into very fine avenues (fig. 12). Unfortunately, however, the amount of material available for filling in is small, so that these old canals are only being filled slowly, and there are many of them. The land around for miles is so flat that if material were dug out for filling these canals, it would simply mean the

formation of other pools where the material was obtained. With regard to the sugar estates, which employ thousands of coolies, the anti-mosquito problem is even more difficult. The only alternative is prophylactic quinine. In British Guiana, therefore, a decided effort is being made to counteract malaria in spite of the difficulties, but they fall far behind Panama in these efforts.

The Americans cleaned up their towns in Panama thoroughly and at once. It would be wisest in the end to do the same in Georgetown. The old canals in the town ought to be filled in without delay. Material cannot be obtained from the land, but it could easily be obtained from the muddy sandy river mouth by means of quite a small suction dredger. A single steam shovel could also do marvels in the soft land, in making further drainage canals in the surrounding country if necessary. During my short visit the floods were very extensive, and it was quite evident that the canals could not cope with the rainfall.

Concerning the water supply and sewage system, they should keep the example of Colon before them. It seems to me that in the long run it would pay to lay down a pipe-borne water supply, even though it had to be brought a long way. After all, water tanks and rain gutters are a makeshift system and must give way to a better some day. The sewage system is a very difficult problem, yet it was solved in Colon by raising the level of the town.

In Georgetown I am glad to be able to state that the streets are well paved, and that even in heavy rain there are no puddles. Cement open gutters run all over the town. The money for this purpose had to be borrowed, but the improvement brought about is immense. There is not a single mosquito-proof house in the town, but water barrels and tanks are carefully proofed so that mosquitos cannot breed in them. This is excellent, but there are still numerous cans, bottles and other rubbish, suitable as breeding places for mosquitos, lying about in yards, especially about the native dwellings. This should be immediately remedied.

With regard to the sugar estates, all water supply barrels are mosquito-proofed (fig. 13), and ankylostomiasis is counteracted by a good latrine system (fig. 14). In addition, a very large amount of quinine is given as a prophylaxis against malaria to the coolies. The result of this has been to reduce the malaria rate to about one-

third of what it was originally. A good cold storage building has been constructed, steps have been taken to improve the abattoir, and a trained sanitary inspector has recently been obtained for the town. Good work is therefore being done, but the great example of Panama shows that it is possible to do much more, and more should be attempted. For further details of the work being done in British Guiana see papers by Dr. K. S. Wise (1911), Dr. E. P. Minett (1912), and Wise and Minett (1912); also the reports of the Surgeon-General (1912). The majority of the medical men in both of these colonies are thoroughly progressive, but unfortunately their progressive ideas are not always duly appreciated. The sanitary organisation in these colonies cannot be compared with the extraordinarily thorough system in Panama. I have stated that there are a few doubtfully trained sanitary inspectors in Trinidad, and only one recently appointed in British Guiana. The medical men have, in consequence, to do practically everything single-handed. It is extraordinary that, alone, they have been able to do so much. The medical men unaided cannot organise such a system as that in Panama. That is a matter which requires the aid of the community and those in authority. Colonel Gorgas has stated emphatically that his system has paid financially and that, furthermore, the money required is well within the means of any tropical country.

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EXPLANATION OF PLATES

PLATE XI

Fig. 1. Old drainage ditch, Colon.

Fig. 2. Street scene to-day, Colon.

Fig. 3. Early street scene, Colon.

Figs. 4 and 5. Thirteenth Street, Panama, before and after the sanitary improvements. All the streets have been renovated in the same manner.

Photos after Avery & Garrison, Panama.

Plate XII

Fig. 6. Mosquito-proof building (Nurses' Home), Ancon Hospital, Panama.

Fig. 7. Native labourers of sanitary staff clearing a swamp preparatory to application of oil. Canal Zone, Panama.

Fig. 8. 'Hydraulic Fill,' Canal Zone, Panama. Only tops of trees visible. Sand and mud not yet dry.

Fig. 9. Ancon cemetery, Panama. Graves of French victims.

Plate XIII

Fig. 10. Old canal in Georgetown, British Guiana, not yet filled in.

Fig. 11. Old canal, Georgetown, British Guiana, which has been filled in with town rubbish.

Fig. 12. Old canal, Georgetown, British Guiana, which has been filled in and transformed into an avenue.

Fig. 13. Coolie range, Diamond Sugar Plantation, Demerara, showing water barrels which are all mosquito-proof.

Fig. 14. Latrines for the coolies at Diamond Sugar Plantation, Demerara.

FIG. 6

FIG. 7

FIG. 8

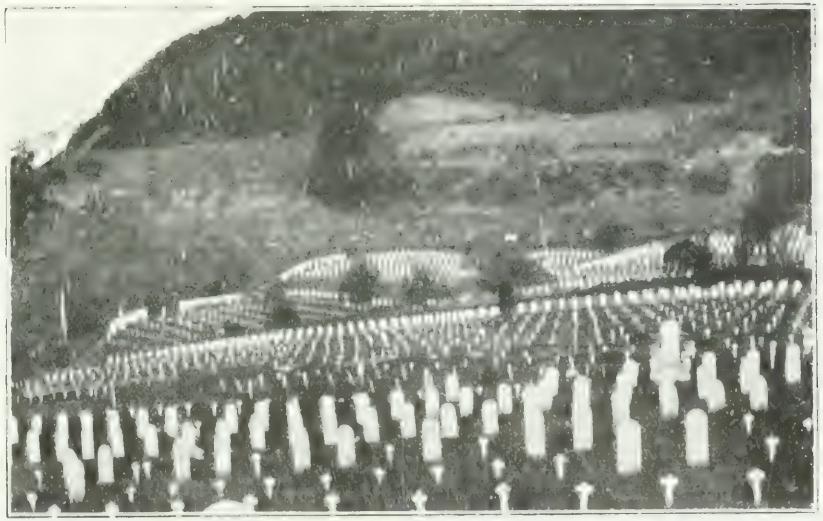

FIG. 9

D. Thomson, photo.

C. Tinling & Co., Ltd., Imp.